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ABSTRACT

This curriculum guide, the fifth in a set of six, contains teacher and student materials for a unit on electrical energy prepared as part of a seventh- and eighth-grade agricultural science curriculum that is integrated with science instruction. The guide contains the state goals and sample learning objectives for each goal for students in grades 8-10 and a teacher presentation outline for the unit. The unit, which begins by listing the agricultural practices and science concepts to be taught, along with activities and applications, contains the following components: teaching steps, lesson outlines, teacher's presentation outlines for each day, student information guide, terms and definitions, worksheets, student activity note sheets, student activity information sheets, student activity record sheets, quizzes, practice problems, and 14 transparency masters. Teacher's activity sheets and tests have answers provided. The unit covers the following topics: providing for the electrical needs of agricultural machines; repair of electrical circuits; designing electrical circuits for agricultural buildings; and estimating electrical power needs for agricultural facilities. (KC)

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ED 367 795

7th and 8th Grade Agriculture Science Curriculum

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Teacher Materials

Electrical Energy

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1. Heat Energy
2. Electromagnetic Spectrum
3. Solar Energy
4. Mechanical Advantage
5. Electrical Energy
6. Energy Conservation

CE 065 788

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ELECTRICAL ENERGY

BIOLOGICAL AND PHYSICAL SCIENCES

STATE GOAL FOR LEARNING 1

As a result of their schooling, students will have a working knowledge of the concepts and basic vocabulary of biological, physical and contemporary technological society.

SAMPLE LEARNING OBJECTIVES FOR GOAL 1

By the end of GRADE 8, students should be able to:

C1. Understand the characteristics of major parts of the atom
F1. Know the laws of conversions of matter, energy, and mass-energy.
H1. Recognize the causes of electric and magnetic forces and fields.
H2. Relate electricity to magnetism.

By the end of GRADE 10, students should be able to:

H1. Identify variables that affect the size of electric and magnetic fields.
O2. Understand force, work, and power.

STATE GOAL FOR LEARNING 3

As a result of their schooling, students will have a working knowledge of the principles of scientific research and their application in simple research projects.

SAMPLE LEARNING OBJECTIVES FOR GOAL 3

By the end of GRADE 8, students should be able to:

A5. Demonstrate effective participation as a member of a laboratory group.
B4. Relate why controlled variables are used in an experiment.
B6. Relate a laboratory procedure that another student can follow.

By the end of GRADE 10, students should be able to:

A1. Replicate the results of an experiment.

STATE GOAL FOR LEARNING 4

As a result of their schooling, students will have a working knowledge of the processes, techniques, methods, equipment and available technology of science.

SAMPLE LEARNING OBJECTIVES FOR GOAL 4

By the end of GRADE 8, students should be able to:

H1. Use an operational definition developed from a simple experiment.
K1. Demonstrate knowledge of an existing scientific model.
L1. Demonstrate reliability by repeating an experiment.

By the end of GRADE 10, students should be able to:

H1. Analyze and operational definition based upon a simple experiment.
K1. Use models to interpret scientific phenomena.

PHYSICAL DEVELOPMENT
STATE GOAL FOR LEARNING 3

As a result of their schooling, students will be able to understand consumer health and safety, including environmental health.

SAMPLE LEARNING OBJECTIVES FOR GOAL 3

By the end of GRADE 8, students should be able to:

A2. Perform with appropriate safety equipment in safe environments.
G1. Know safety procedures needed in schools and the home to prevent accidents.

By the end of GRADE 10, students should be able to:

A2. Perform with appropriate safety equipment in safe environments.

LANGUAGE ARTS
STATE GOAL FOR LEARNING 4

As a result of their schooling, students will be able to use spoken language effectively in formal and informal situations to communicate ideas and information and to ask and answer questions.

SAMPLE LEARNING OBJECTIVES FOR GOAL 4

By the end of GRADE 8, students should be able to:

C2. Distinguish among statements of observation, opinion, and judgment.

MATHEMATICS

STATE GOAL FOR LEARNING 1

As a result of their schooling, students will be able to perform the computations of addition, subtraction, multiplication, and division using whole numbers, integers, fractions, and decimals.

SAMPLE LEARNING OBJECTIVES FOR GOAL 1

By the end of GRADE 8, students should be able to:

B4. Multiply and divide integers with and without a calculator.
H4 Read diagrams, flowcharts, and schematics.

STATE GOAL FOR LEARNING 2

As a result of their schooling, students will be able to understand and use ratios and percentages.

SAMPLE LEARNING OBJECTIVES FOR GOAL 2

By the end of GRADE 8, students should be able to:

B1. Set up proportions to correspond to appropriate English statements of relationships among quantities.

STATE GOAL FOR LEARNING 4

As a result of their schooling, students will be able to identify, analyze and solve problems using algebraic equations, inequalities, functions and their graphs.

SAMPLE LEARNING OBJECTIVES FOR GOAL 4

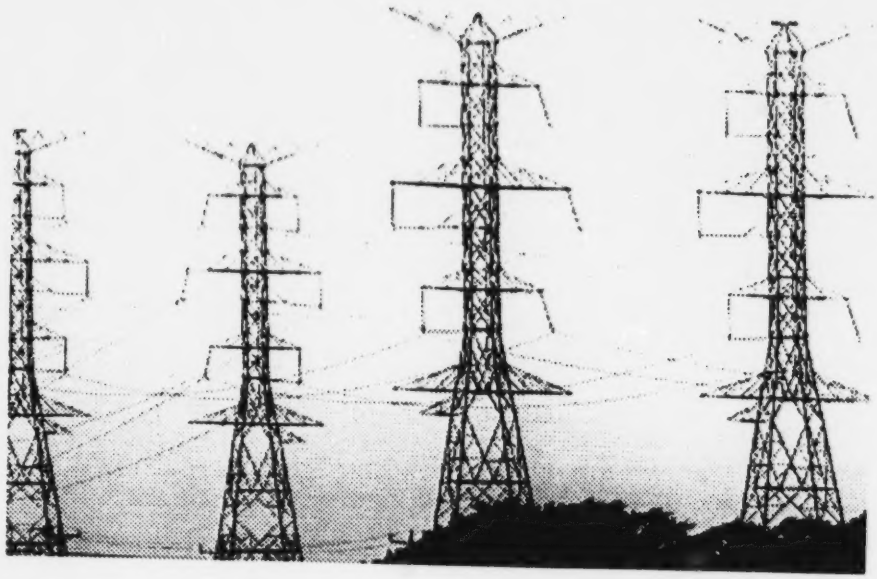
By the end of GRADE 8, students should be able to:

D2. Solve for a variable in a simple formula when given values for all other variables.
D3. Use values from a real situation for the variables in a formula and solve.

By the end of GRADE 10, students should be able to:

F4. Multiply binomials.

ELECTRICAL ENERGY



TEACHER PRESENTATION OUTLINE

ELECTRICAL ENERGY

AGRICULTURAL PRACTICES

Provide for electrical needs of Agricultural Machinery.
Repair electrical circuits.
Design electrical circuits for Agricultural Buildings.
Estimate electrical power needs for Ag facilities.

SCIENCE CONCEPTS

Scientific Model of Electricity
Atomic Structure
Electron Flow
Characteristics of Electricity

AGRICULTURAL APPLICATIONS FOR 7&8TH GRADE PHYSICAL SCIENCES:

UNIT TITLES:	ACTIVITIES & APPLICATIONS
Electrical Energy	1. Electric fence; pg 4 2. Farm engines; pg 5 3. Lightening cows; pg 6 4. Electric saw; pg 22 5. Chicken circuit pg 25

TEACHING STEPS

(for teacher to follow)

A. Materials Provided in Teaching Kit:

- Generator
- Power strip with a switch
- #14 wire
- Light switch
- Switch Box

B. Additional Materials Needed for Student Activities:

- Colored Pencils, Crayons, or Markers
- Light Bulb
- Screwdriver

- Completed Switch boxes for students (Optional Student Activity - 2)

- 10 screw drivers (Optional Student Activity - 2)

C. Lesson Outline

D. Teacher's Presentation Outline

E. Audio Visual Materials:

1. TYPES OF ELECTRICITY
2. ATOMIC STRUCTURE
3. ELECTRON FLOW
4. ELECTRICITY FORMULAS
5. ELECTRICITY & WORK
6. CHARACTERISTICS
7. VOLTS, AMPS, WATTS
8. AMPS
9. VOLTS
10. WATTS
11. POWER PROBLEM
12. KILOWATT HOURS
13. COST
14. WIRING CHART

F. Student Handouts and Quizzes

Student Information Guide
Work Sheet A
Work Sheet B
Work Sheet C
Work Sheet D
Student Activity Notes Sheet
Student Activity - 1 Information Sheet
Student Activity - 1 Record Sheet
Student Activity Information Sheet - 2
Quiz 1
Quiz 2

LESSON OUTLINE:

Day 1:

Discussion of Attention Step/Problem Statement.
Scientific Explanation of Electrical Energy.
Student Completion of Work Sheet A during Class.
Explanation of Scientific Terms.
Student Completion of Work Sheet B during Class or as Homework.
Individual Study Using Computer Study Guide.

Day 2:

Discussion of Scientific Terms Work Sheet (Work Sheet B).
Explanation of General Information about Electrical Energy.
Demonstration of Generation of Electrical Current.
Explanation of Importance of Electrical Energy.
Explanation of Electrical Energy Generation.
Student Completion of Work Sheet C during Class.
Individual Study Using Computer Study Guide.

Day 3:

Review of Information on Scientific Explanation of Electrical Energy and Electrical Energy generation.
Student Completion of Work Sheet D during Class.
Student Completion of Quiz 1.
Individual Study Using Computer Study Guide.

Day 4:

Teacher Demonstration of Design of Electrical Circuit.
Assignment of Student Activity Note Sheet.
Student Activity of Diagraming an Electrical Circuit.
Individual Evaluation Using Computer Quiz.

Day 5:

Discussion of Student Activity, "Diagraming an Electrical Circuit".
Completion of Optional Student Activity, "Construction of an Electrical Circuit".
Individual Evaluation Using Computer Quiz.
Student Completion of Quiz 2.

ELECTRICAL ENERGY

TEACHER'S PRESENTATION OUTLINE

Day 1

Teaching Note: *Discuss the Attention Step/Problem Statement with the class.*

ATTENTION STEP/PROBLEM STATEMENT:

Electrical energy is an important part of daily life for us. We use electricity many times during the day. Examples range from: heating water for taking a shower in the morning to using electricity to watch an evening movie on television. What you may not know is that electricity is part of you. You have an electrical charge which changes every day. Some days you are more electrically charged than others. We can measure the amount of this charge. Reasons for the difference in your electricity charge are due to such items as the moisture in the air, the types of materials you have been near and what you have been doing today. When you touch a door knob and get a shock, this is a transfer of the electricity from your body to the metal door knob. The door knob is a good conductor and is transferring electrons from you to the door. This is the same electricity we use to do work. Electricity is used to do work on livestock farms, when farmers use electrically charged wires as a barrier for their animals. We call this an "electric" fence. How we use electricity to do work for us, is what this lesson is about.

OBJECTIVES:

KNOWLEDGE OBJECTIVES:

Students will know:

- The scientific model of electricity
- Three forces used to make electricity
- Characteristics of conductors
- Characteristics of insulators
- The formula for computing electrical power
- The definition of Watts, Ohms, Volts and Amps

PERFORMANCE OBJECTIVES:

Students will:

- Generate an electrical force
- Measure the force generated
- Compute the cost of electrical power
- Design an electric circuit
- Prepare an electrical circuit

ELECTRICAL ENERGY

Teaching Note: *Explain the following information about the Scientific Explanation of electrical energy to the class. (Some teachers may want to explain the Scientific Terms and assign Work Sheet B before starting the Scientific Explanation of Electrical Energy.)*

Scientific Explanation of Electrical Energy

Lecture Note: Use Overhead #1 (Types of Electricity).

Electricity is the movement of electrons. The movement of the electrons is produced through some type of force. There are three types of force which can be used to produce electrical movement. The three forces used to produce electricity are: static, chemical and mechanical.

Static electricity is producing an electrical charge resulting from friction. An example of static electricity is rubbing your shoe on a carpet then touching a metal door knob.

Chemical electricity is electrical production caused by a chemical process. An automotive battery is an example of process.

Mechanical electricity is electricity that is produced by motion. Producing mechanical energy requires a magnetic field, conductors, and motion. Examples of mechanical electrical energy include a generator at a power plant which produces the electricity we use in our homes or the ignition system of gasoline engine which produces an electrical spark to start farm tractors and other gas engines used in agriculture.

Next, we will discuss the **Scientific model** of electricity. A scientific model is a description of a part of nature which helps us understand how electricity works. The model is a drawing which represents how scientists believe electricity works. To understand the production of electricity it is important to review the structure of atoms.

Lecture Note: *Use overhead #2 (Atomic Structure).*

All matter is composed of atoms. Atoms contain 3 basic parts. These parts are called protons, neutrons and electrons. Electrons travel in orbits around the atom and carry negative electrical charges. Protons are large heavy particles, when compared to the electrons. One or more protons are included in the nucleus of the atom and protons are positively charged. Neutrons are made up of an electron and a proton bound together, for this reason they are electrically neutral. Neutrons and Protons are located at the center of an atom.

The atom is held together because unlike charges attract, and the number of (+) protons are equal to the number of (-) electrons. While unlike charges attract, like charges repel each other. This is why (-) electrons will not collide with each other in their orbit around atoms.

Lecture Note: *Use overhead #3 (Electron Flow).*

Atoms of some materials like Copper contain electrons which are easily moved from one copper atom to another copper atom. Look at the drawing on overhead 3 and notice an electron is leaving the atom. When electrons move or flow, we call their flow an electrical current. The flow of electrons is an electrical current. Copper allows electrons to flow easily when compared to many other materials. This property of Copper is one reason why we use copper wires for electrical circuits in our homes.

Remember there are three means of getting electrons to move. These are Static, Chemical and Mechanical. Electrons move from a place of extra electrons or (-) charge to a place of an absence of electrons or a (+) charge. When you rub your shoe on a carpet you are adding electrons to your body. Your body is becoming negatively charged. When you touch another person with a more positive charge, some of your extra electrons will move to their body. A shock or spark of electricity will occur when you do this. In our daily lives, we take advantage of the way electricity moves.

We use the understanding of electricity to do work for us and to keep ourselves away from dangerous forms of electricity. A thunderstorm collects huge numbers of extra electrons. Enough to seriously injure or even cause death to you and I. Each year hundreds of people are killed or injured by lightening strikes. On an Ohio dairy farm, nearly twenty cows were killed by one lightening strike as they huddled under a large tree for protection from a violent thunderstorm. Knowing about electricity can save your life.

Teaching Note: *Assign Work Sheet A and Student Information Guide on Electrical Energy to the class. Students can complete Work Sheet A either individually or in small groups during class time.*

STUDENT INFORMATION GUIDE

ELECTRICITY

Electricity is the movement of electrons. The movement of the electrons is produced through some type of force. There are three types of force which can be used to produce electrical movement. The three forces used to produce electricity are: static, chemical and mechanical.

Static electricity is producing an electrical charge resulting from friction. An example of static electricity is rubbing your shoe on a carpet then touching a metal door knob.

Chemical electricity is electrical production caused by a chemical process. An automotive battery is an example of process.

Mechanical electricity is electricity that is produced by motion. Producing mechanical energy requires a magnetic field, conductors, and motion. Examples of mechanical electrical energy include a generator at a power plant which produces the electricity we use in our homes or the ignition system of gasoline engine which produces an electrical spark to start a car.

Next, we will discuss the **Scientific model** of electricity. A scientific model is a description of a part of nature which helps us understand how electricity works. The model is a drawing which represents how scientists believe electricity works. To understand the production of electricity it is important to review the basics of atomic structure. All matter is composed of atoms. Atoms contain 3 basic parts. These parts are called protons, neutrons and electrons. Electrons travel in orbits around the atom and carry a negative electrical charges. Protons are large heavy particles, when compared to the electrons. One or more protons are included in the nucleus of the atom and protons are positively charged. Neutrons are made up of an electron and a proton bound together, for this reason they are electrically neutral. Neutrons are located at the center of an atom.

The atom is held together because unlike charges attract, and the number of (+) protons are equal to the number of (-) electrons. While unlike charges attract, like charges repel each other. This is why (-) electrons will not collide with each other in their orbit around an atom.

Atoms of some materials like copper contain electrons which are easily moved from one copper atom to another copper atom. When electrons move or flow, we call their flow an electrical current. The flow of electrons is an electrical current. Copper allows electrons to flow easily when compared to many other materials. This property of copper is one reason why we use copper wires for electrical circuits in our homes.

Remember there are three means of getting electrons to move. These are Static, Chemical and Mechanical. Electrons move from a place of extra electrons or (-) charge to a place of an absence of electrons or a (+) charge. When you rub your shoe on a carpet you are adding electrons to your body. Your body is becoming negatively charged. When you touch another person with a more positive charge, some of your extra electrons will move to their body. A shock or spark of electricity will occur when you do this. In our daily lives, we take advantage the way electricity moves.

We use the understanding of electricity to do work for us and to keep ourselves away from dangerous forms of electricity. A thunderstorm collects huge numbers of extra electrons. Enough to seriously injure or even cause death to you and I. Each year hundreds of people are killed or injured by lightening strikes. Knowing about electricity can save your life.

We use electricity to do work for us. Many times we use electricity to make something move. When electricity is created by electrical generation, motion is used to create electricity.

Several features of electricity make it the form of energy we prefer in many cases. Electricity is know as the cheap, clean and safe source of energy. It can be easily and safely transported from place to place. If you want an energy source on the back porch of your home, just attach an electrical wire to the main electrical box of your house and extend it to the back porch. Electricity is also a cheap form of energy. The use of a 100 watt light for one hour will cost about a penny in most areas of the U.S.

Electricity is used to operate a variety of tools and equipment. To operate them safely, we must understand some of the basic features of electricity. Knowing three terms will help us get started. These are Amps, Volts, and Watts.

Amps: A measure of the speed of electrical movement.

Volts: A measure of the amount of electricity.

Watts: A measure of power. Watts is the result of multiplying Volts times Amps.

The Electrical Power Formula
The electrical power formula is E x I = P. E is equal to the number of volts. I is equal to the number of Amps. The result of E x I is the number of Watts of power. To determine the amount of electricity used by your television set, read the information from the back of the TV set which lists the electrical power requirements needed to operate the TV set. For example, a TV sets power requirements may read as follows: 120 volts and 2 amps. This TV will use 120 volts x 2 amps or 240 watts of power when it is turned on. Look at an electric heater. It may read 110 volts and 15 amps. The heater will use 110 volts x 15 amps or 1650 watts when it is used. Look at the volt and amp ratings of several appliances and determine their power use.

The cost of electrical power can be determined by combining the power used answer with the amount of time the electricity was used.

For example, if the TV was used for 10 hours, the following formula can be used to determine the amount of electricity the power company will charge for the use of the TV for 10 hours.

Multiply the Power number times the hours of use and divide by 1000 to determine an answer which is called kilowatt hours.

For the TV, Multiply 120 volts x 10 amps to = 1200 watts. Divide 1200 watts by 1000 to = 1.2 kilowatt hours. The number 1.2 represents the number of kilowatt hours of electricity used.

Next we need to know the price the power company charges for the use of one kilowatt of electricity. An average price of a kilowatt of electricity used for one hour is 12 cents. If we multiply 1.2 kilowatts x 12 cents, the answer is 14.4 cents. So we can say it will cost about 14.4 cents to pay for the electricity needed to operate the TV for 10 hours.

GLOSSARY OF SCIENTIFIC TERMS:

Electricity -	The collection of electrons which produces a negative charge.
Neutrons -	The combination of a proton and an electron which results in a neutral charge.
Electrons -	A part of an atom which contains a negative charge.
Protons -	The part of an atom which has a positive charge.
Chemical Electricity -	The collection of negative charges caused by the reaction of chemicals.
Mechanical Electricity -	The collection of negative charges caused by motion.
Static Electricity -	The collection of negative charges caused by friction.
Scientific Model -	A means of explaining a part of nature.
Electrical Current -	The movement of electrons.

Electric Circuit -	A path which can be used to conduct electricity.
Amps -	A measure of the speed of electrical movement.
Volts -	A measure of the amount of electricity.
Watts -	A measure of power. Watts is the result of multiplying Volts times Amps.
Conductors -	A material which allows electricity to move easily.
Insulators -	A material which keeps electricity from moving.
Kilowatt Hour -	A measure electrical use. A Kilowatt is use of 1000 watts of power for one hour.
Generator -	A mechanical device which caused electrons to move.

WORK SHEET A

Directions: Complete the following questions.

1. Electricity can be defined as the movement of *electrons* .

2. The three types force used to produce electricity :

   a. *static*

   b. *chemical*

   c. *mechanical*

3. The *scientific model* of electricity is a description of nature which helps us understand electricity.

4. Three basic parts of all atoms are:

   a. *electrons*

   b. *protons*

   c. *neutrons*

5. The movement of electricity is called *electric current* .

6. The addition of electrons to a material is called a *negative* charge.

7. Electrons move from a place of a *negative* charge to a place of a *positive* charge.

8. A natural event which can collect huge numbers of electrons and may be dangerous to humans is a *thunderstorm* .

Teaching Note: *Explain the following terms to the class and then assign Work Sheet B. The students can find the definitions for these terms in the Student Information Guide. Students can complete Work Sheet B during class time or as homework.*

Glossary of Scientific Terms:

Electricity:	The collection of electrons which produces a negative charge.
Neutrons:	The combination of a proton and an electron which results in a neutral charge.
Electrons	A part of an atom which contains a negative charge.
Protons:	The part of an atom which has a positive charge.
Chemical Electricity:	The collection of negative charges caused by the reaction of chemicals.
Mechanical Electricity:	The collection of negative charges caused by motion.
Static Electricity:	The collection of negative charges caused friction.
Scientific Model:	A means of explaining a part of nature.
Electrical Current:	The movement of electrons.
Electric Circuit:	A path which can be used to conduct electricity.

Lecture Note: *Use overhead # 4 (Electricity Formulas) to explain amps, volts, and watts.*

Amps:	A measure of the speed of electrical movement.
Volts:	A measure of the amount of electricity.
Watts:	A measure of power. Watts is the result of multiplying Volts times Amps.
Conductors:	A material which allows electricity to move easily.
Insulators:	A material which keeps electricity from moving.
Kilowatt Hour:	A measure electrical use. A Kilowatt is the use of 1000 watts of power for one hour.
Generator:	A mechanical device which causes electrons to be moved.

WORK SHEET B

Directions:

The answers to the following fill-in-the-blank questions are terms which have to do with Electrical Energy. Choose the term from the word list below that best answers each question. Each term may be used only once.

Word List:

Electricity	Electric Circuit	
Neutrons	Electrical Current	Volts
Electrons	Generator	Amps
Protons	Scientific Model	Watts
Chemical Electricity	Static Electricity	Conductors
Mechanical Electricity	Insulators	Kilowatt Hour

Fill-in-the-blank:

1. ***CHEMICAL ELECTRICITY*** — The collection of negative charges caused by the reaction of chemicals.
2. ***PROTON*** — The part of an atom which has a positive charge.
3. ***ELECTRIC CIRCUIT*** — A path which can be used to conduct electricity.
4. ***ELECTRICAL CURRENT*** — The movement of electrons.
5. ***ELECTRICITY*** — The collection of electrons which produces a negative charge.
6. ***AMPS*** — A measure of the speed of electrical movement.
7. ***VOLTS*** — A measure of the amount of electricity.
8. ***STATIC ELECTRICITY*** — The collection of negative charges caused by friction.
9. ***INSULATOR*** — A material which keeps electricity from moving.
10. ***GENERATOR*** — A mechanical device which caused electrons to be moved.
11. ***CONDUCTOR*** — A material which allows electricity to move easily.

12. ***KILOWATT HOUR*** — A measure of electrical use. The use of 1000 watts of power for one hour.

13. ***WATTS*** — A measure of power, is the result of multiplying Volts times Amps.

14. ***ELECTRON*** — A part of an atom which contains a negative charge.

15. ***SCIENTIFIC MODEL*** — A means of explaining a part of nature.

16. ***MECHANICAL ELECTRICITY*** — The collection of negative charges caused by motion.

17. ***NEUTRON*** — The combination of a proton and an electron which results in a neutral charge.

Day 2

Teaching Note: *Discuss the Scientific Term Work Sheet (Work Sheet B) with the class.*

Teaching Note: *Explain the following general information about Electrical Energy to the class.*

General Information about Electrical Energy

Lecture Note: *Use overhead # 5 (Electricity & Work).*

ELECTRICITY AND WORK

We use electricity to do work for us. Many times we use electricity to make something move. When electricity is created by electrical generation, motion is used to create electricity.

Teaching Note: *Demonstrate the generation of an electrical current. If a voltmeter is available the current produced can be measured. The activity and demonstration steps are summarized below:*

Preparation: *An electrical generator is provided as part of the teaching materials. The concept to demonstrate is that motion can be used to generate an electrical current. By turning the handle of the generator, an electrical current is produced. The current is large enough to operate a small light. The teacher should practice the demonstration before trying it with the class. An additional activity could include measuring the electrical current produced with a meter.*

Activity Summary: *Assemble the generator as directed and place the red wire in the red receptacle and the blue wire in the blue receptacle. Turn the handle to light the light. If you wish to do the additional activity of measuring the current with a volt meter, remove the light and place the meter wires in the red and blue receptacles. Set the meter on the 2.5V DC setting and turn the handle. You should note the relationship between how fast the wheel is turned and the Volt reading. You should easily be able to generate 1 Volt and more by turning the handle faster.*

Teaching Demonstration Notes:

Turning the red handle on the plastic generator will produced enough electricity to light the bulb. Electrical power generators we depend on are powered by forms of motion. Water falls are used to turn wheels which produce electricity. Gasoline or oil is used as an energy source for portable electrical generators. The small gasoline generators which you can buy at discount stores such as Sears or KMart create electricity from motion. The motion of the gas engine is converted to electricity to provide power for our homes when the "power is out".

Teaching Note: *Explain the following information about the importance of Electrical Energy to the class.*

Importance of Electrical Energy

Lecture Note: *Use overhead # 6 (Characteristics)*

Several features of electricity make it the form of energy we prefer in many cases. Electricity is know as the cheap, clean and safe source of energy. It can be easily and safely transported from place to place. If you want an energy source on the back porch of your home, just attach an electrical wire to the main electrical box of your house and extend it to the back porch. Electricity is also a cheap form of energy. The use of a 100 watt light for one hour will cost about a penny in most areas of the U.S.

Lecture Note: *Use overhead # 7 (Volts, amps, watts).*

Electricity is used to operate a variety of tools and equipment. To operate them safely, we must understand some of the basic features of electricity. Knowing three terms will help us get started. These are Amps, Volts, and Watts.

Lecture Note: *Use overhead # 8 (AMPS).*

Amps: A measure of the speed of electrical movement.

Lecture Note: *Use overhead # 9 (VOLTS).*

Volts: A measure of the amount of electricity.

Lecture Note: *Use overhead # 10 (WATTS).*

Watts: A measure of power. Watts is the result of multiplying Volts times Amps.

Teaching Note: *Explain the following information about using the electrical power formula to the class.*

The Electrical Power Formula

Lecture Note: *Use overhead # 11 (Compute Power).*

The electrical power formula is E x I = P. E is equal to the number of volts. I is equal to the number of Amps. The result of E x I is the number of Watts of power. To determine the amount of electricity used by your television set, read the information from the back of the TV set which lists the electrical power requirements needed to operate the TV set. For example, a TV sets power requirements may read as follows: 120 volts and 2 amps. This TV will use 120 volts x 2 amps or 240 watts of power when it is turned on. Look at an electric heater. It may read 110 volts and 15 amps. The heater will use 110 volts x 15 amps or 1650 watts when it is used. Look at the volt and amp ratings of several appliances and determine their power use.

The cost of electrical power can be determined by combining the power used answer with the amount of time the electricity was used.

Lecture Note: *Use overhead # 12 (Kilowatt Hours).*

For example, if the TV was used for 10 hours, the following formula can be used to determine the amount of electricity the power company will charge for the use of the TV for 10 hours. Multiply the Power number times the hours of use and divide by 1000 to determine an answer which is called kilowatt hours. For the TV, Multiply 120 volts x 10 amps to = 1200 watts. Divide 1200 watts by 1000 to = 1.2 kilowatt hours. The number 1.2 represents the number of kilowatt hours of electricity used.

Lecture Note: *Use overhead # 13 (The Cost of Electrical power).*

Next we need to know the price the power company charges for the use of one kilowatt of electricity. An average price of a kilowatt of electricity used for one hour is 12 cents. If we multiply 1.2 kilowatts x 12 cents, the answer is 14.4 cents. So we can say it will cost about 14.4 cents to pay for the electricity needed to operate the TV for 10 hours.

Teaching Note: *Assign Work Sheet C to the class. Students can complete Work Sheet C either individually or in small groups during class time.*

WORK SHEET C

Directions: Complete the following questions.

A. Fill-in-the-blank:

1. Electricity is known as the ___cheap___, ___clean___, and ___safe___, source of energy.

2. In most areas of the US, the cost of operating a 100 watt light for one hour will cost about ___one cent___.

3. ___Amps___ is the measure of the speed of electrical movement.

4. ___Volts___ is a measure of the amount of electricity.

5. ___Watts___ is a measure of power and is the result of multiplying Volts times Amps.

6. The electrical power formula is E x I = P.
E is equal to the number of volts needed.
I is equal to the number of Amps needed.
The result of E x I is the number of Watts of power used.

   Determine the kilowatt hours of electricity used by a toaster oven. The toaster oven uses 120 volts and 6 amps when it is used. You plan to use it for 2 hours to bake food.

   E = 120 volts
   I = 6 amps
   E x I = P
   E x I = 120 x 6 = ***720 watts***

   720 watts are used when the oven is in operation.

   Hours X watts divided by 1000 = kilowatts used.

   2 x 720 = 1440 divided by 1000 = ***1.440 kilowatts*** used.

7. Next, determine the cost of baking food for 2 hours. The cost of electricity is 18 cents per kilowatt hour.

   Cost = Price per kilowatt x number of kilowatt hours used.

   Price per kilowatt = 18 cents
   Number of kilowatt hours used = 1.44

   Cost = ___18___ cents x ___1.44___ kilowatt hours

   Cost = ___25.92___ cents. This is the cost of baking food for two hours in the Toaster Oven.

Teaching Note: *The students may use the written Study Guide or the Computer Program for individual study and review of this lesson.*

Day 3

Teaching Note: *Review information about the Scientific Model of Electricity, and the electrical power formulas needed to determine watts and cost of electricity.*

The **Scientific Model** of electricity.
- All matter is composed of atoms.

- Atoms contain 3 parts. These parts are called protons, neutrons and electrons.

  Electrons travel in orbits around the atom and carry a negative electrical charges.

  Protons are large heavy particles when compared to the electrons, one or more protons are included in the nucleus of the atom and are positively charged.

  Neutrons are made up of an electron and a proton bound together, for this reason they are electrically neutral. Neutrons are located in the nucleus of the atom.

- The atom is held together because unlike charges attract, and the number of (+) protons are equal to the number of (-) electrons. While unlike charges attract, like charges repel each other. This is why (-) electrons will not collide with each other in their orbit around the nucleus.

Electrical Power Formulas
- The electrical power formula is E x I = P.

  E is equal to the number of volts.

  I is equal to the number of amps.

  The result of E x I is the number of Watts of power used.

- To determine the amount of electricity used by an appliance, read the following information from the appliance. An electric saw may read as follows: 110 volts and 10 amps. This saw will use 110 volts x 11 amps or 1100 watts of power when it is turned on.

- The cost of electrical power can be determined by combining the power used answer with the amount of time the electricity was used.

  For example, if the electric saw was used for 4 hours, the following formula can be used to determine the amount of electricity the power company will charge you.

- Multiply the Power number times the hours of use and divide by 1000 to determine an answer which is called kilowatt hours.
  For the electric Saw, Multiply 1100 watts x 4 hours = 4400.

- Divide 4400 by 1000 = 4.4 The number 4.4 represents the number of kilowatt hours of electricity used.

- Next we need to know the price the power company charges for electricity. Lets take an average price of 12 cents per kilowatt hour.

  If we multiply 4.4 kilowatt hours x 12 cents, the answer is 52.8 cents. So we can say it will cost about 50 cents to pay for the electricity needed to operate the electric saw for 4 hours.

Teaching Note: *Students should complete Work Sheet D: Student Review during class time.*

Teaching Note: *The students may use the written Study Guide or the Computer Program for individual study and review of this lesson.*

Teaching Note: *After students complete Work Sheet D, Quiz 1 can be used to evaluate student's knowledge of electrical energy.*

WORK SHEET D: STUDENT REVIEW

Solve the following problems.

1. The electrical power formula is E x I = P.
   E is equal to the number of volts.

   I is equal to the number of amps.

   The result of E x I is the number of *Watts* of power used.

2. Determine the cost of operating a heater. The heater uses 120 volts and 12 amps when it is used. You plan to use it for 3 hours to warm up a large room. The cost of electricity is 14 cents per kilowatt hour.

   a. First find the number of watts that are used when the heater is in operation.

      E = *120* volts

      I = *12* amps

      E x I = P
      120 volts x 12 amps = *1440* watts

   1440 watts are used when the heater is in operation.

   b. Next find the kilowatts of electricity used to operate the heater.

      Hours multiplied by watts divided by 1000 = kilowatts used.

      3 hours x 1440 watts = 4323 divided by 1000 = *4.323* kilowatt hours used.

   c. Next, determine the cost of operating the heater for 3 hours. The cost of electricity is 14 cents per kilowatt hour.

      Cost = Price per kilowatt hour times the number of kilowatt hours used.

      Price per kilowatt hour = 14 cents
      Number of kilowatt hours used = 4.323

      Cost = *14* cents x *4.323* kilowatt hours

      Cost = *60.522* cents. The cost of operating this heater for three hours is about 60 cents.

QUIZ 1

A. Matching:

Match the best definition with each term:

b	1. Amps	a.	A measure of electrical use. The use of 1000 watts of power for 1 hour.
a	2. Kilowatt Hour	b.	The speed of electrical movement.
d	3. Watts	c.	A measure of the amount of electricity.
c	4. Volts	d.	A measure of power resulting from volts x amps.

B. True or False:

T 5. Static electricity is producing electrical charges resulting from friction.

T 6. An example of chemical electricity is found in batteries.

T 7. Mechanical electricity is electricity that is produced by motion.

C. Fill-in-the-blank:

8. Electrons travel in orbits around the atom and carry a *negative* electrical charge.

9. Protons are large particles which carry a *positive* electrical charge.

D. Short Answer:

10. If an electrical light used 100 watts for 30 hours and the cost of electricity is 20 cents per kilowatt answer the following questions.

How many kilowatts are used?
100 X 30 = 3000 / 1000 = 3 kilowatts

What is the cost of using the light for 30 hours?
3 X 20 = 60 cents

Day 4

Teaching Note: *Assign the Student Activity Note Sheets to students.*

Teaching Note: *Demonstrate the Construction of an Electrical Circuit Activity. The steps and procedures are found in the Guide for Teacher Demonstration, "Construction of an Electrical Circuit." Students need to take notes and record them on the Student Activity Note Sheet during the teacher demonstration. After the teacher demonstration, students will participate in Student Activity - 1, "Diagraming an Electrical Circuit". On DAY 5 and after the teacher demonstration, students may also participate in an optional activity of wiring an electrical circuit in small groups. The construction of electrical circuits have many applications in agriculture. The design of a box which contains a light as does this demonstration will produce enough heat to hatch chicken eggs. If this device were placed in a small container with a dozed "fertilized" eggs, it would be called an incubator.*

GUIDE FOR TEACHER DEMONSTRATION

CONSTRUCTION OF AN ELECTRICAL CIRCUIT.

A. Purpose:

The teacher will demonstrate the construction of an electrical circuit with the materials listed below. After the demonstration, students may participate in an optional activity of constructing an electrical circuit.

- Plywood board with switch and light receptacle
- Cover plates for switch and light.
- small screw driver
- Electrical strip with 15 amp fuse installed.
- Cord plug & wires

Teacher Note: *Identify and explain the parts of the electrical circuit to the class.*

The electrical strip will be the power supply. The 15 amp fuse in the power strip will provide protection for the light we are wiring as well as the power supply in the room. If our wiring creates a short, the fuse in the strip will protect the electricity supply in the room from being interrupted.

Teacher Note: ***Use the table of information below to explain the limitations of materials you are using in this demonstration. This table provides data regarding the maximum amps for each wire size. What this means is, a #14 wire can conduct 15 amps of electricity. Therefore, to make the wiring circuit safe, we need to use a fuse or a circuit breaker no larger than 15 amps for a circuit which uses a #14 wire. Notice you are using #14 wire and the fuse size of the strip is 15 amps. The circuit is safe in terms of selecting the proper fuse. We chose a 15 amp fuse because, the wiring circuit in the walls of your classroom may be completed with a 15 amp fuse.***

CURRENT CARRYING CAPACITY
for copper wire sizes

WIRE SIZE	MAXIMUM AMPS
14	15
12	20
10	25
8	35

NOTE: #14 is a small wire, #12 is the normal size wire used in most homes. A number #10 or larger will be used to wire a large appliance such as an electric clothes dryer or an electric stove. The smaller the wire number, the larger the wire.

Teacher Note: ***Using the table below, explain how electrical wires are color coded. Explain to students that only like colors will be connected when performing the electrical circuit activity.***

COLOR CODING OF WIRE

BLACK WIRE is the HOT WIRE

WHITE WIRE is the NEUTRAL WIRE

GREEN WIRE is the GROUND WIRE

Teacher Note: ***Explain the steps in the Wiring Exercise.***

Lecture Note: Use overhead # 14 (Wiring Chart). Then demonstrate wiring an electrical circuit on an actual light box.

Steps in the Wiring Exercise:

1. Connect the light wires to the wires in the light box.

Attach the light receptacle wires to the wires in the light box. Use two wire nuts. Make sure the wire nut is tight. After attaching these wires, try to pull on the wire nut. If it is loose tighten before closing the light box.

Teacher Note: *Follow the wire color codes in making these connections. Be sure to attach black wires to black wires and white wires to white wires. Connect the black wire (also known as the hot wire) to the dark screw of the light. Place the curved wire on the screw from left to right. This will allow the screw to pull the wire into the connection as you tighten the screw. If you place the wire on the screw in the opposite direction, the tightening process will push the wire away from the connection. Next connect the white wire (also known as the neutral wire) to the silver screw on the light. Next, connect the green wire to the green screw (this is known as the ground wire).*

Notice, a ground wire has been attached to the box. This is a safety feature. If the electrical wires you push into the box happen to touch the edge of the metal box, the ground wire will conduct electricity back through its wire and eventually to the ground. If ground wires were not used, the electricity might provide you a shock.

2. Close the light box.

Use the long silver metal screws to close the light box. Be sure to push wires firmly into the light box. Also make sure the wire nuts do not become loose.

3. Connect the wires in the switch box.

Next wire the switch. Place the black wires on the screws of the switch. Use the wire nut to connect the white wires. Notice the ground wires are attached to the box.

4. Close the switch box.

Push the wired switch into its box and use the metal screws to keep the switch in place. Now attach the switch cover plate.

Put a light bulb in the light socket.

5. Plug in and try the light.

Plug your wired light into the electrical power strip and use the switch to turn on the light. Congratulations you have used electricity to work for you.

STUDENT ACTIVITY NOTE SHEET

DIRECTIONS:

TAKE NOTES DURING THE TEACHER DEMONSTRATION OF CONSTRUCTION OF AN ELECTRICAL CIRCUIT & RECORD THEM ON THESE NOTE SHEETS.

A. Purpose:

To Learn How an Electrical Circuit is Constructed

B. Materials Needed:

The teacher will demonstrate the construction of an electrical circuit with the materials listed below.

- **Plywood board with switch and light receptacle**
- **Cover plates for switch and light.**
- **Small screw driver**
- **Electrical strip with 15 amp fuse installed.**
  The electrical strip will be the power supply. The 15 amp fuse in the power strip will provide protection for the light we are wiring as well as the power supply in the room. If our wiring creates a short, the fuse in the strip will protect the electricity supply in the room from being interrupted.
- **Cord plug & wires**

CURRENT CARRYING CAPACITY
for copper wire sizes

WIRE SIZE	MAXIMUM AMPS
14	15
12	20
10	25
8	35

NOTE: #14 is a small wire, #12 is the normal size wire used in most homes. A number #10 or larger will be used to wire a large appliance such as an electric clothes dryer or an electric stove. The smaller the wire number, the larger the wire.

COLOR CODING OF WIRE

———————— BLACK WIRE is the HOT WIRE

---------- WHITE WIRE is the NEUTRAL WIRE

– · – · – · – · – GREEN WIRE is the GROUND WIRE

c. Here's How:

List Steps in the Wiring Exercise as your teacher demonstrates how the circuit is wired:

1. Connect the light wires to the wires in the light box.

2. Close the light box.

3. Connect the wires in the switch box

4. Close the switch box.

5. Plug in and try the light.

STUDENT ACTIVITY - 1
INFORMATION SHEET

DIAGRAMING AN ELECTRICAL CIRCUIT
(Activity to be completed after the teacher's demonstration of wiring a switch and a light)

a. **Purpose:**
to diagram an electrical circuit.

b. **What Each Group of Students Needs:**
colored pencils or markers
Student Activity - 1 Record Sheet

c. **Here's How:**

1. Work in your assigned groups.

2. Use your Student Activity Note Sheet from the demonstration of "Constructing an Electrical Circuit" as a guide for completing this activity.

3. Answer the questions in Part A of the Student Activity - 1 Record Sheet.

4. Draw a diagram of the Electrical Circuit your teacher demonstrated in Part B of the Student Activity - 1 Record Sheet. Use colored pencils, markers, or crayons to color code wires and connections.

5. After you have completed your diagram, explain it to your teacher and/or class.

STUDENT ACTIVITY - 1
RECORD SHEET

A. Answer the Questions:

Teaching Note: *Teacher may need to assist students in answering some of these questions.*

1. *Which color of wire is known as the HOT wire ? Which colors are the neutral and ground wire?*

   BLACK IS HOT

   WHITE IS NEUTRAL

   GREEN IS GROUND

2. How many watts of power are available on a circuit which has a 15 AMP fuse and a 110 volt source?

   15 AMPS x 110 VOLTS = 1650 WATTS

3. What is the purpose of the ground wire?

   A SAFETY DEVICE TO RETURN ELECTRICITY

4. What could you do to protect a coffee pot which needs 5 AMPS and 110 volts from overheating or drawing too much current when it is plugged in on a 20 AMP 110 VOLT circuit?

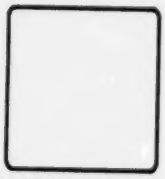
   PLACE A 5 AMP FUSE IN THE WIRE WHICH LEADS TO THE COFFEE POT

B. DRAW THE CIRCUIT:

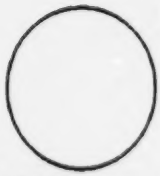
Draw the circuit your teacher constructed in the space below. Using colored pencils, indicated the correct color coding of wires and connections. See the table below.

PLUG STRIP

SWITCH BOX



LIGHT BOX

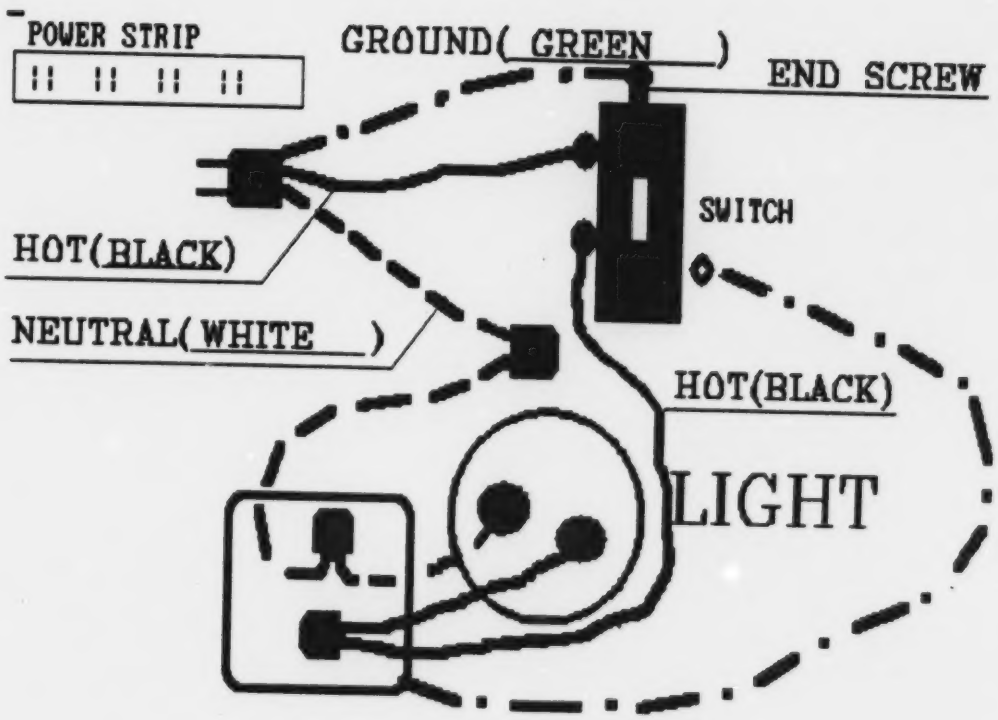


LIGHT

KEY TO COLOR CODING OF WIRE AND CONNECTIONS:

BLACK	HOT WIRE
WHITE	NEUTRAL WIRE
GREEN OR BARE	GROUND WIRE
GOLD SCREW	HOT WIRE
SILVER SCREW	NEUTRAL WIRE
GREEN OR END SCREW	GROUND WIRE

SCHEMATIC OF WIRING AN ELECTRICAL CIRCUIT



Teaching Note: *The students may use the Electric Computer Quiz for individual evaluation of their knowledge on electric power.*

Day 5

Teaching Note: ***Discuss Student Activity - 1, "Diagraming an Electrical Circuit" with the students.***

Teaching Note: *(Optional Student Activity - 2)*
Student Activity - 2, "Constructing an Electrical Circuit" is optional, but can be completed at this time if desired. This activity involves the students wiring the same electrical circuit that the teacher demonstrated on DAY 4. The steps and procedures are found in Student Activity - 2 Information Sheet. Assign Student Activity - 2 Information Sheet, "Constructing an Electrical Circuit" to the students. Students can also use the Student Activity Note Sheets and Student Activity - 1 Record Sheet as a guide for completing this activity.

Teaching Note: *(Optional Student Activity - 2)*
Provide the students with supplies for the student activity and answer any questions. Coordinate the student activity.
CAUTION: Check all wiring before students plug their circuits into the electrical power strip. Students must plug their circuit into the electrical power strip, not directly into an electrical outlet. Teacher should supervise students working with the electrical power strip.

Teaching Note: *(Optional Student Activity - 2)*
Discuss Student Activity - 2 after the students have completed it.

Teaching Note: *The students may use the Electricity Computer Quiz for individual evaluation of their knowledge on electric power.*

Teaching Note: *Quiz 2 can be used to evaluate student's knowledge of Electricity.*

STUDENT ACTIVITY - 2
INFORMATION SHEET
CONSTRUCTING AN ELECTRICAL CIRCUIT

(Activity to be completed after the teacher's demonstration of wiring a switch and a light)

a. Purpose:

to construct an electrical circuit.

b. What Each Group of Students Needs:

Wood board with switch Box, Light Box and cord mounted.
#14 copper wires cut for assembly.
Switch
Light receptacle
Light bulb
Switch cover plate
Metal screws for switch plate & light receptacle
Screw driver
Wire nut for the switch box
2 wire nuts for attaching the light receptacle

c. Here's How:

Work in your assigned groups. Use your Student Activity Note Sheet from your teachers demonstration of constructing an electrical circuit as a guide for completing this activity.

1. CONNECT LIGHT WIRES TO WIRES IN THE LIGHT BOX

Attach the light receptacle wires to the wires in the light box. Use two wire nuts. Make sure the wire nut is tight. After attaching these wires, try to pull on the wire nut. If it is loose tighten before closing the light box.

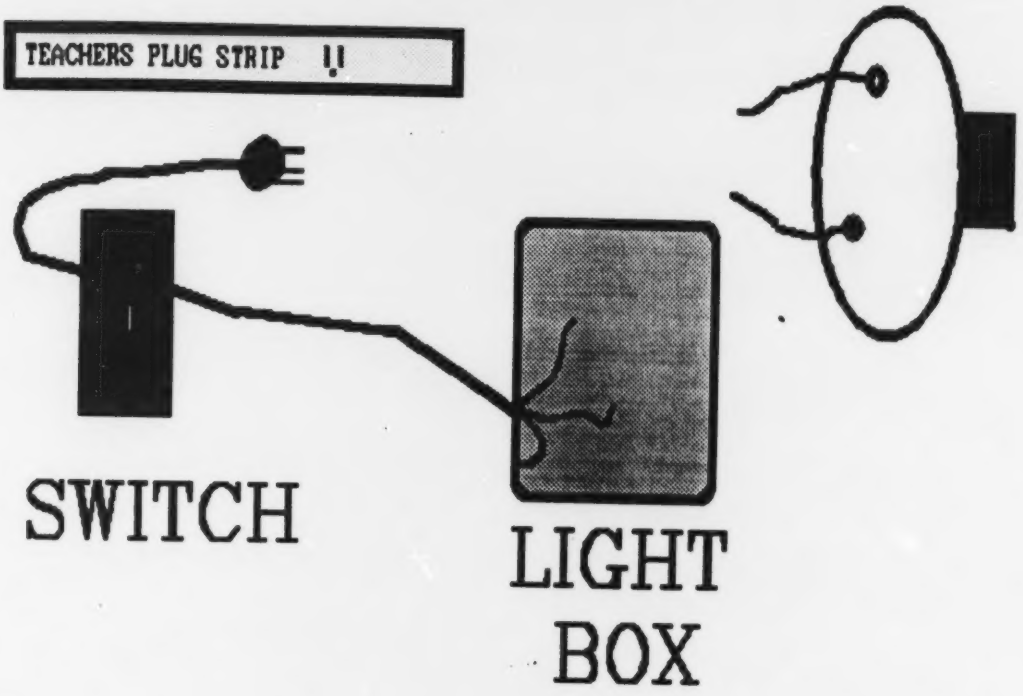
Follow the wire color codes in making these connections. Be sure to attach black wires to black wires and white wires to white wires.

Notice, a ground wire has been attached to the box. This is a safety feature. If the electrical wires you push into the box happen to touch the edge of the metal box, the ground wire will conduct electricity back through its wire and eventually to the ground. If ground wires were not used, the electricity might provide you a shock.

2. CLOSE THE LIGHT BOX

Use the long silver metal screws to close the light box. Be sure to push wires firmly into the light box. Also make sure the wire nuts do not become loose.

LIGHT SWITCH WIRING DIAGRAM



3. CONNECT WIRES IN THE SWITCH BOX

Next wire the switch. Place the black wires on the screws of the switch. Use the wire nut to connect the white wires. Notice the ground wires are attached to the box.

4. CLOSE THE SWITCH BOX

Push the wired switch into its box and use the metal screws to keep the switch in place. Now attach the switch cover plate.

Put a light bulb in the light socket.

5. PLUG IN AND TRY THE LIGHT

Show the wired light to your teacher. After your teacher has checked your wiring, Plug your wired light into the teachers power strip and use the switch to turn on the light. **CAUTION: ONLY PLUG YOUR LIGHT INTO THE POWER STRIP AND ONLY WITH YOUR TEACHER'S APPROVAL.** Congratulations you have used electricity to work for you. Now, clean up your work area.

QUIZ 2

A. Matching:

Match the best definition with each term:

a	1.	Black	a.	Hot wire
c	2.	White	b.	Ground wire.
b	3.	Green	c.	Neutral wire.
b	4.	Bare		

B. True or False:

T 5. Static electricity is producing electrical charges resulting from friction.

T 6. An example of chemical electricity is found in batteries.

T 7. Mechanical electricity is electricity that is produced by motion.

C. Fill-in-the-blank:

8. Electrons travel in orbits around the atom and carry a *NEGATIVE* electrical charge.

9. Protons are large particles which carry a *POSITIVE* electrical charge.

D. Short Answer:

10. If an electrical heater used 500 watts for 10 hours and the cost of electricity is 20 cents per kilowatt answer the following questions.

How many kilowatts are used?
500 x 10 = 5000 / 1000 = 5 KILOWATTS

What is the cost of using the heater for 10 hours?
5 x .20 = $ 1.00

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Smith, Herbert A., Frazier, Ralph P., and Magnoli, Michael A., Activities for Exploring Living Things. River Forest, IL: Laidlaw Publishers, 1977.

D. Audio Visual Materials:

1. TYPES OF ELECTRICITY
2. ATOMIC STRUCTURE

3. ELECTRON FLOW
4. ELECTRICITY FORMULAS

5. ELECTRICITY & WORK
6. CHARACTERISTICS

7. VOLTS, AMPS, WATTS
8. AMPS

9. VOLTS
10. WATTS

11. POWER PROBLEM
12. KILOWATT HOURS

13. COST
14. WIRING CHART

OH1

TYPES OF ELECTRICITY

1. STATIC

 - PICK UP ON A RUG

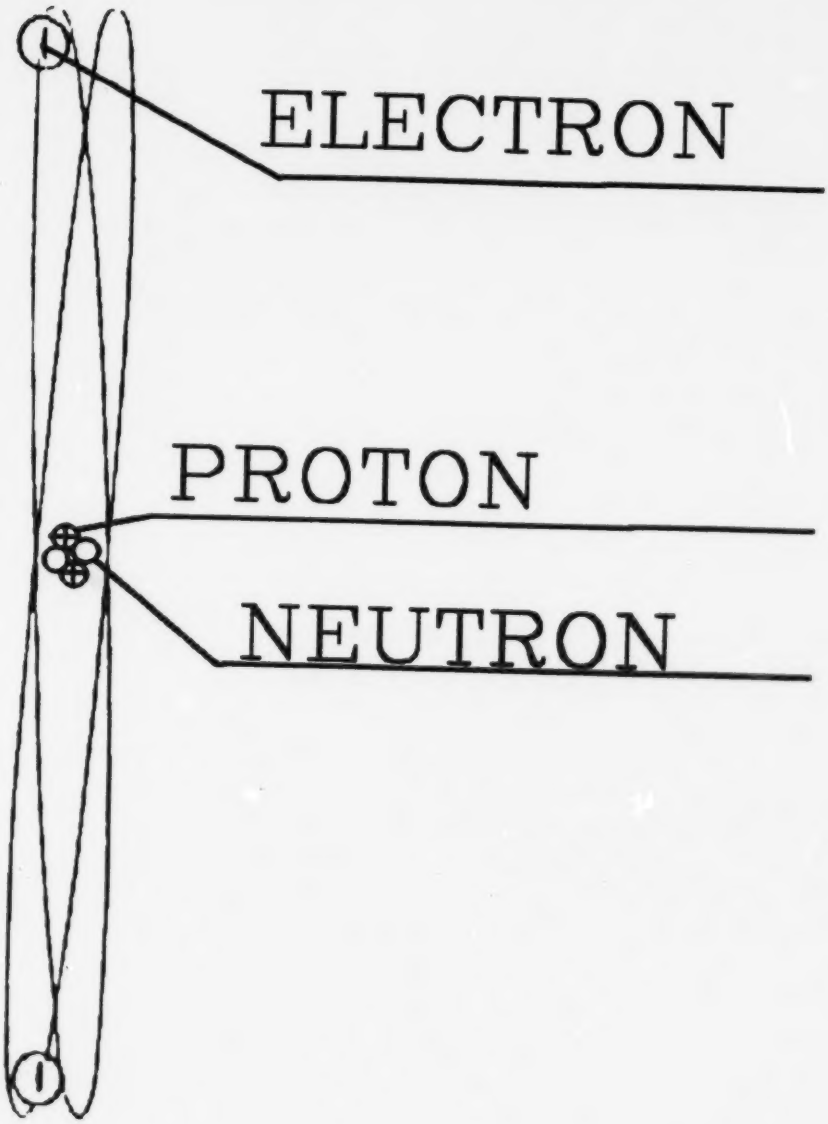
2. CHEMICAL

 - IN A BATTERY

3. MECHANICAL

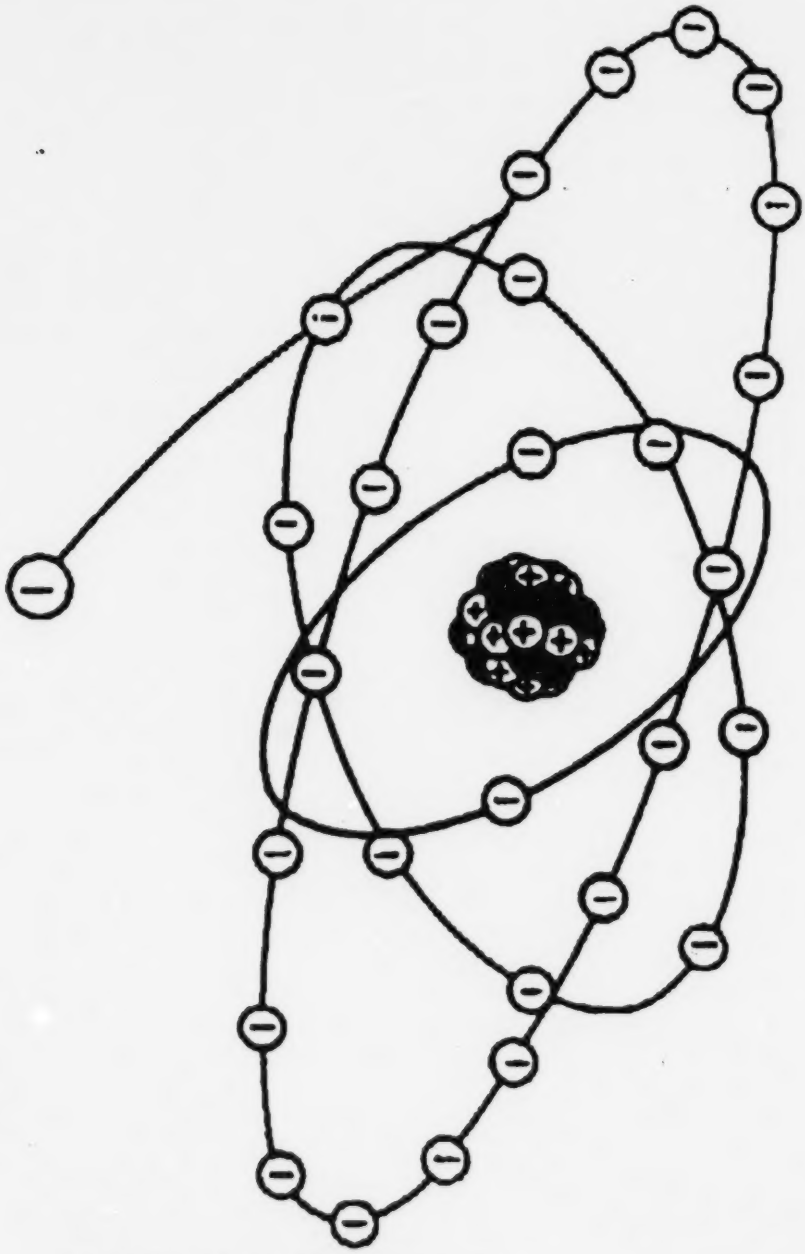
 - FROM MOTION
 - WATERFALLS
 - COAL TO STEAM

ATOMIC STRUCTURE



OH3

ELECTRON FLOW



CONDUCTORS
ELECTRONS
CAN LEAVE

OH4

ELECTRICITY FORMULAS

POWER IS MEASURED BY WATTS

AMPS = SPEED OF ELECTRONS

VOLTS = SIZE OF FORCE

WATTS = AMPS x VOLTS

MEASURE OF POWER = WATTS

OH5

ELECTRICITY & WORK

MOTION CAN PRODUCE ELECTRICITY

WE USE SEVERAL MEANS OF PRODUCING ELECTRICITY BY MOTION

SOME OF THESE ARE

- WATERFALLS
- BURNING FOSSIL FUELS
  COAL & OIL
- NUCLEAR REACTORS

USE THE HAND GENERATOR AND TURN IT TO PRODUCE ELECTRICITY

OH6

CHARACTERISTICS

1. CHEAP

- ONE CENT FOR 10 HOURS OF LIGHT

2. SAFE

- USE OF COPPER WIRES IN OUR HOMES

3. CLEAN

- CAN CLEAN UP POLLUTION AT ONE LOCATION

OH7

VOLTS, AMPS, WATTS

E SYMBOL FOR VOLTS

I SYMBOL FOR AMPS

P SYMBOL FOR WATTS

E times I = P

VOLTS times AMPS = WATTS

OH8

AMPS

Amps: ... A measure of the speed of electrical movement.

OH9

VOLTS

Volts: A measure of the amount of electricity.

OH10

WATTS

Watts: A measure of power. Watts is the result of multiplying Volts times Amps.

OH11

POWER PROBLEM

E times I = P

TV VOLTS; E = 120

TV AMPS; I = 1

120 times 1 = 120 WATTS

OH12

KILOWATT HOURS

DETERMINE HOW LONG POWER WAS USED

MULTIPLY WATTS times HOURS AND divide BY 1000

USE TV FOR 10 HOURS

WATTS times HOURS divided BY 1000

120 X 10 = 1200

1200 divided by 1000

= 1.2 KILOWATT HOURS

OH13

COST

COST IS 12 CENTS PER KILOWATT HOUR

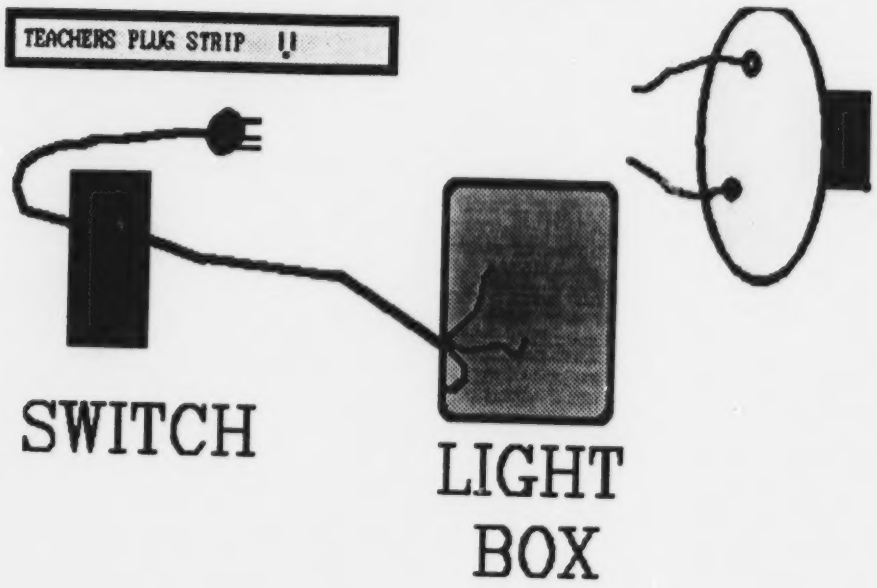
NUMBER OF KILOWATT HOURS times COST PER KILOWATT HOUR

1.2 times 12 cents = 14.4 cents

THE COST OF OPERATING THE TV FOR 10 HOURS IS 14.4 CENTS

OH14

WIRING CHART



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1. CONNECT LIGHT WIRES TO WIRES IN THE LIGHT BOX
2. CLOSE THE LIGHT BOX
3. CONNECT WIRES IN THE SWITCH BOX
4. CLOSE THE SWITCH BOX
5. PLUG IN AND TRY THE LIGHT

E. Student Handouts and Quizzes

Student Information Guide - ELECTRICITY

Work Sheet A

Work Sheet B

Work Sheet C

Work Sheet D

Student Activity Note Sheet

Student Activity - 1 Information Sheet

Student Activity - 1 Record Sheet

Student Activity - 2 Information Sheet

Quiz 1

Quiz 2

STUDENT INFORMATION GUIDE

ELECTRICITY

Electricity is the movement of electrons. The movement of the electrons is produced through some type of force. There are three types of force which can be used to produce electrical movement. The three forces used to produce electricity are: static, chemical and mechanical.

Static electricity is producing an electrical charge resulting from friction. An example of static electricity is rubbing your shoe on a carpet then touching a metal door knob.

Chemical electricity is electrical production caused by a chemical process. An automotive battery is an example of process.

Mechanical electricity is electricity that is produced by motion. Producing mechanical energy requires a magnetic field, conductors, and motion. Examples of mechanical electrical energy include a generator at a power plant which produces the electricity we use in our homes or the ignition system of gasoline engine which produces an electrical spark to start a car.

Next, we will discuss the **Scientific model** of electricity. A scientific model is a description of a part of nature which helps us understand how electricity works. The model is a drawing which represents how scientists believe electricity works. To understand the production of electricity it is important to review the basics of atomic structure. All matter is composed of atoms. Atoms contain 3 basic parts. These parts are called protons, neutrons and electrons. Electrons travel in orbits around the atom and carry a negative electrical charges. Protons are large heavy particles, when compared to the electrons. One or more protons are included in the nucleus of the atom and protons are positively charged. Neutrons are made up of an electron and a proton bound together, for this reason they are electrically neutral. Neutrons are located at the center of an atom.

The atom is held together because unlike charges attract, and the number of (+) protons are equal to the number of (-) electrons. While unlike charges attract, like charges repel each other. This is why (-) electrons will not collide with each other in their orbit around an atom.

Atoms of some materials like copper contain electrons which are easily moved from one copper atom to another copper atom. When electrons move or flow, we call their flow an electrical current. The flow of electrons is an electrical current. Copper allows electrons to flow easily when compared to many other materials. This property of copper is one reason why we use copper wires for electrical circuits in our homes.

Remember there are three means of getting electrons to move. These are Static, Chemical and Mechanical. Electrons move from a place of extra electrons or (-) charge to a place of an absence of electrons or a (+) charge. When you rub your shoe on a carpet you are adding electrons to your body. Your body is becoming negatively charged. When you touch another person with a more positive charge, some of your extra electrons will move to their body. A shock or spark of electricity will occur when you do this. In our daily lives, we take advantage the way electricity moves.

We use the understanding of electricity to do work for us and to keep ourselves away from dangerous forms of electricity. A thunderstorm collects huge numbers of extra electrons. Enough to seriously injure or even cause death to you and I. Each year hundreds of people are killed or injured by lightening strikes. Knowing about electricity can save your life.

We use electricity to do work for us. Many times we use electricity to make something move. When electricity is created by electrical generation, motion is used to create electricity.

Several features of electricity make it the form of energy we prefer in many cases. Electricity is know as the cheap, clean and safe source of energy. It can be easily and safely transported from place to place. If you want an energy source on the back porch of your home, just attach an electrical wire to the main electrical box of your house and extend it to the back porch. Electricity is also a cheap form of energy. The use of a 100 watt light for one hour will cost about a penny in most areas of the U.S.

Electricity is used to operate a variety of tools and equipment. To operate them safely, we must understand some of the basic features of electricity. Knowing three terms will help us get started. These are Amps, Volts, and Watts.

Amps: A measure of the speed of electrical movement.

Volts: A measure of the amount of electricity.

Watts: A measure of power. Watts is the result of multiplying Volts times Amps.

The Electrical Power Formula
The electrical power formula is E x I = P. E is equal to the number of volts. I is equal to the number of Amps. The result of E x I is the number of Watts of power. To determine the amount of electricity used by your television set, read the information from the back of the TV set which lists the electrical power requirements needed to operate the TV set. For example, a TV sets power requirements may read as follows: 120 volts and 2 amps. This TV will use 120 volts x 2 amps or 240 watts of power when it is turned on. Look at an electric heater. It may read 110 volts and 15 amps. The heater will use 110 volts x 15 amps or 1650 watts when it is used. Look at the volt and amp ratings of several appliances and determine their power use.

The cost of electrical power can be determined by combining the power used answer with the amount of time the electricity was used.

For example, if the TV was used for 10 hours, the following formula can be used to determine the amount of electricity the power company will charge for the use of the TV for 10 hours.

Multiply the Power number times the hours of use and divide by 1000 to determine an answer which is called kilowatt hours.

For the TV, Multiply 120 volts x 10 amps to = 1200 watts. Divide 1200 watts by 1000 to = 1.2 kilowatt hours. The number 1.2 represents the number of kilowatt hours of electricity used.

Next we need to know the price the power company charges for the use of one kilowatt of electricity. An average price of a kilowatt of electricity used for one hour is 12 cents. If we multiply 1.2 kilowatts x 12 cents, the answer is 14.4 cents. So we can say it will cost about 14.4 cents to pay for the electricity needed to operate the TV for 10 hours.

GLOSSARY OF SCIENTIFIC TERMS:

Electricity -	The collection of electrons which produces a negative charge.
Neutrons -	The combination of a proton and an electron which results in a neutral charge.
Electrons -	A part of an atom which contains a negative charge.
Protons -	The part of an atom which has a positive charge.
Chemical Electricity -	The collection of negative charges caused by the reaction of chemicals.
Mechanical Electricity -	The collection of negative charges caused by motion.
Static Electricity -	The collection of negative charges caused by friction.
Scientific Model -	A means of explaining a part of nature.
Electrical Current -	The movement of electrons.

Electric Circuit -	A path which can be used to conduct electricity.
Amps -	A measure of the speed of electrical movement.
Volts -	A measure of the amount of electricity.
Watts -	A measure of power. Watts is the result of multiplying Volts times Amps.
Conductors -	A material which allows electricity to move easily.
Insulators -	A material which keeps electricity from moving.
Kilowatt Hour -	A measure electrical use. A Kilowatt is use of 1000 watts of power for one hour.
Generator -	A mechanical device which caused electrons to move.

WORK SHEET A

Directions: Complete the following questions.

1. Electricity can be defined as the movement of _____.

2. The three types force used to produce electricity :

   a. _____

   b. _____

   c. _____

3. The _____ of electricity is a description of nature which helps us understand electricity.

4. Three basic parts of all atoms are:

   a. _____

   b. _____

   c. _____

5. The movement of electricity is called _____.

6. The addition of electrons to a material is called a _____ charge.

7. Electrons move from a place of a _____ charge to a place of a _____ charge.

8. A natural event which can collect huge numbers of electrons and may be dangerous to humans is a _____.

WORK SHEET B

Directions:

The answers to the following fill-in-the-blank questions are terms which have to do with Electrical Energy. Choose the term from the word list below that best answers each question. Each term may be used only once.

Word List:

Electricity	Electric Circuit	
Neutrons	Electrical Current	Volts
Electrons	Generator	Amps
Protons	Scientific Model	Watts
Chemical Electricity	Static Electricity	Conductors
Mechanical Electricity	Insulators	Kilowatt Hour

Fill-in-the-blank:

1. _____ The collection of negative charges caused by the reaction of chemicals.
2. _____ The part of an atom which has a positive charge.
3. _____ A path which can be used to conduct electricity.
4. _____ The movement of electrons.
5. _____ The collection of electrons which produces a negative charge.
6. _____ A measure of the speed of electrical movement.
7. _____ A measure of the amount of electricity.
8. _____ The collection of negative charges caused by friction.
9. _____ A material which keeps electricity from moving.
10. _____ A mechanical device which caused electrons to be moved.
11. _____ A material which allows electricity to move easily.

12. _____ A measure of electrical use. The use of 1000 watts of power for one hour.

13. _____ A measure of power, is the result of multiplying Volts times Amps.

14. _____ A part of an atom which contains a negative charge.

15. _____ A means of explaining a part of nature.

16. _____ The collection of negative charges caused by motion.

17. _____ The combination of a proton and an electron which results in a neutral charge.

WORK SHEET C

Directions: Complete the following questions.

A. Fill-in-the-blank:

1. Electricity is known as the _____, _____, and _____, source of energy.

2. In most areas of the US, the cost of operating a 100 watt light for one hour will cost about _____.

3. _____ is the measure of the speed of electrical movement.

4. _____ is a measure of the amount of electricity.

5. _____ is a measure of power and is the result of multiplying Volts times Amps.

6. The electrical power formula is E x I = P.
   E is equal to the number of volts needed.
   I is equal to the number of Amps needed.
   The result of E x I is the number of Watts of power used.

   Determine the kilowatt hours of electricity used by a toaster oven. The toaster oven uses 120 volts and 6 amps when it is used. You plan to use it for 2 hours to bake food.

   E = 120 volts
   I = 6 amps
   E x I = P
   E x I = 120 x 6 = _____

   720 watts are used when the oven is in operation.

   Hours X watts divided by 1000 = kilowatts used.

   2 x 720 = 1440 divided by 1000 = _____ used.

7. Next, determine the cost of baking food for 2 hours. The cost of electricity is 18 cents per kilowatt hour.

   Cost = Price per kilowatt x number of kilowatt hours used.

   Price per kilowatt = 18 cents
   Number of kilowatt hours used = 1.44

   Cost = _____ cents x _____ kilowatt hours

   Cost = _____ cents. This is the cost of baking food for two hours in the Toaster Oven.

WORK SHEET D: STUDENT REVIEW

Solve the following problems.

1. The electrical power formula is E x I = P.
_____ is equal to the number of volts.

_____ is equal to the number of amps.

The result of E x I is the number of _____ of power used.

2. Determine the cost of operating a heater. The heater uses 120 volts and 12 amps when it is used. You plan to use it for 3 hours to warm up a large room. The cost of electricity is 14 cents per kilowatt hour.

a. First find the number of watts that are used when the heater is in operation.

E = ____ volts

I = ____ amps

E x I = P
120 volts x 12 amps = _____ watts

1440 watts are used when the heater is in operation.

b. Next find the kilowatts of electricity used to operate the heater.

Hours multiplied by watts divided by 1000 = kilowatts used.

3 hours x 1440 watts = 4323 divided by 1000 = _____ kilowatt hours used.

c. Next, determine the cost of operating the heater for 3 hours. The cost of electricity is 14 cents per kilowatt hour.

Cost = Price per kilowatt hour times the number of kilowatt hours used.

Price per kilowatt hour = 14 cents
Number of kilowatt hours used = 4.323

Cost = _____ cents x _____ kilowatt hours

Cost = _____ cents. The cost of operating this heater for three hours is about 60 cents.

STUDENT ACTIVITY NOTE SHEET

DIRECTIONS:

TAKE NOTES DURING THE TEACHER DEMONSTRATION OF CONSTRUCTION OF AN ELECTRICAL CIRCUIT & RECORD THEM ON THESE NOTE SHEETS.

A. **Purpose:** To Learn How an Electrical Circuit is Constructed

B. **Materials Needed:**
The teacher will demonstrate the construction of an electrical circuit with the materials listed below.

- **Plywood board with switch and light receptacle**
- **Cover plates for switch and light.**
- **Small screw driver**
- **Electrical strip with 15 amp fuse installed.**
  The electrical strip will be the power supply. The 15 amp fuse in the power strip will provide protection for the light we are wiring as well as the power supply in the room. If our wiring creates a short, the fuse in the strip will protect the electricity supply in the room from being interrupted.
- **Cord plug & wires**

CURRENT CARRYING CAPACITY
for copper wire sizes

WIRE SIZE	MAXIMUM AMPS
14	15
12	20
10	25
8	35

NOTE: #14 is a small wire, #12 is the normal size wire used in most homes. A number #10 or larger will be used to wire a large appliance such as an electric clothes dryer or an electric stove. The smaller the wire number, the larger the wire.

COLOR CODING OF WIRE

BLACK WIRE is the HOT WIRE

WHITE WIRE is the NEUTRAL WIRE

GREEN WIRE is the GROUND WIRE

c. **Here's How**
List Steps in the Wiring Exercise as your teacher demonstrates how the circuit is wired:

1. Connect the light wires to the wires in the light box.

2. Close the light box.

3. Connect the wires in the switch box

4. Close the switch box.

5. Plug in and try the light.

STUDENT ACTIVITY - 1
INFORMATION SHEET

DIAGRAMING AN ELECTRICAL CIRCUIT
(Activity to be completed after the teacher's demonstration of wiring a switch and a light)

a. **Purpose:**
to diagram an electrical circuit.

b. **What Each Group of Students Needs:**
colored pencils or markers
Student Activity - 1 Record Sheet

c. **Here's How:**

1. Work in your assigned groups.

2. Use your Student Activity Note Sheet from the demonstration of "Constructing an Electrical Circuit" as a guide for completing this activity.

3. Answer the questions in Part A of the Student Activity - 1 Record Sheet.

4. Draw a diagram of the Electrical Circuit your teacher demonstrated in Part B of the Student Activity - 1 Record Sheet. Use colored pencils, markers, or crayons to color code wires and connections.

5. After you have completed your diagram, explain it to your teacher and/or class.

STUDENT ACTIVITY - 1
RECORD SHEET

A. Answer the Questions:

1. Which color of wire is known as the HOT wire ? Which colors are the neutral and ground wire?

2. How many watts of power are available on a circuit which has a 15 AMP fuse and a 110 volt source?

3. What is the purpose of the ground wire?

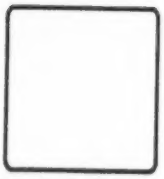
4. What could you do to protect a coffee pot which needs 5 AMPS and 110 volts from overheating or drawing too much current when it is plugged in on a 20 AMP 110 VOLT circuit?

B. DRAW THE CIRCUIT:

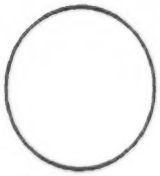
Draw the circuit your teacher constructed in the space below. Using colored pencils, indicated the correct color coding of wires and connections. See the table below.

PLUG STRIP

SWITCH BOX



LIGHT BOX



LIGHT

KEY TO COLOR CODING OF WIRE AND CONNECTIONS:

BLACK	HOT WIRE
WHITE	NEUTRAL WIRE
GREEN OR BARE	GROUND WIRE
GOLD SCREW	HOT WIRE
SILVER SCREW	NEUTRAL WIRE
GREEN OR END SCREW	GROUND WIRE

STUDENT ACTIVITY - 2
INFORMATION SHEET
CONSTRUCTING AN ELECTRICAL CIRCUIT

(Activity to be completed after the teacher's demonstration of wiring a switch and a light)

a. Purpose:

to construct an electrical circuit.

b. What Each Group of Students Needs:

Wood board with switch Box, Light Box and cord mounted.
#14 copper wires cut for assembly.
Switch
Light receptacle
Light bulb
Switch cover plate
Metal screws for switch plate & light receptacle
Screw driver
Wire nut for the switch box
2 wire nuts for attaching the light receptacle

c. Here's How:

Work in your assigned groups. Use your Student Activity Note Sheet from your teachers demonstration of constructing an electrical circuit as a guide for completing this activity.

1. CONNECT LIGHT WIRES TO WIRES IN THE LIGHT BOX

Attach the light receptacle wires to the wires in the light box. Use two wire nuts. Make sure the wire nut is tight. After attaching these wires, try to pull on the wire nut. If it is loose tighten before closing the light box.

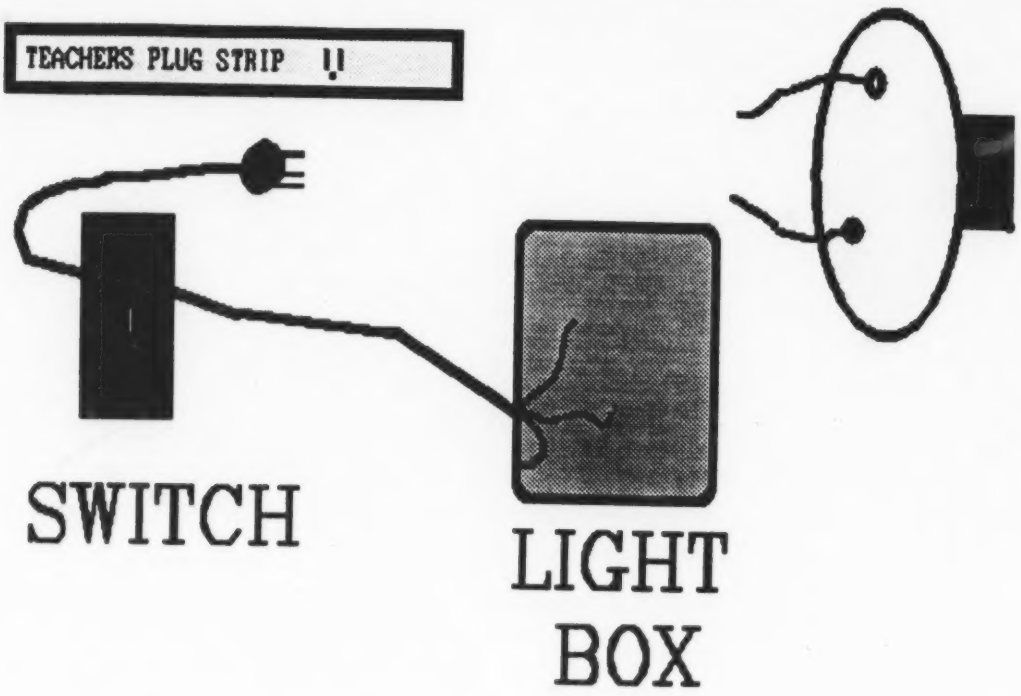
Follow the wire color codes in making these connections. Be sure to attach black wires to black wires and white wires to white wires.

Notice, a ground wire has been attached to the box. This is a safety feature. If the electrical wires you push into the box happen to touch the edge of the metal box, the ground wire will conduct electricity back through its wire and eventually to the ground. If ground wires were not used, the electricity might provide you a shock.

2. CLOSE THE LIGHT BOX

Use the long silver metal screws to close the light box. Be sure to push wires firmly into the light box. Also make sure the wire nuts do not become loose.

LIGHT SWITCH WIRING DIAGRAM



3. CONNECT WIRES IN THE SWITCH BOX

Next wire the switch. Place the black wires on the screws of the switch. Use the wire nut to connect the white wires. Notice the ground wires are attached to the box.

4. CLOSE THE SWITCH BOX

Push the wired switch into its box and use the metal screws to keep the switch in place. Now attach the switch cover plate.

Put a light bulb in the light socket.

5. PLUG IN AND TRY THE LIGHT

Show the wired light to your teacher. After your teacher has checked your wiring, Plug your wired light into the teachers power strip and use the switch to turn on the light.
CAUTION: ONLY PLUG YOUR LIGHT INTO THE POWER STRIP AND ONLY WITH YOUR TEACHER'S APPROVAL. Congratulations you have used electricity to work for you. Now, clean up your work area.

QUIZ 1

A. Matching:

Match the best definition with each term:

_____1.	Amps	a.	A measure of electrical use. The use of 1000 watts of power for 1 hour.
_____2.	Kilowatt Hour	b.	The speed of electrical movement.
_____3.	Watts	c.	A measure of the amount of electricity.
_____4.	Volts	d.	A measure of power resulting from volts x amps.

B. True or False:

_____ 5. Static electricity is producing electrical charges resulting from friction.

_____ 6. An example of chemical electricity is found in batteries.

_____ 7. Mechanical electricity is electricity that is produced by motion.

C. Fill-in-the-blank:

8. Electrons travel in orbits around the atom and carry a _____ electrical charge.

9. Protons are large particles which carry a _____ electrical charge.

D. Short Answer:

10. If an electrical light used 100 watts for 30 hours and the cost of electricity is 20 cents per kilowatt answer the following questions.

How many kilowatts are used? _____

What is the cost of using the light for 30 hours? _____

QUIZ 2

A. Matching:

Match the best definition with each term:

_____1.	Black	a.	Hot wire
_____2.	White	b.	Ground wire.
_____3.	Green	c.	Neutral wire.
_____4.	Bare		

B. True or False:

_____ 5. Static electricity is producing electrical charges resulting from friction.

_____ 6. An example of chemical electricity is found in batteries.

_____ 7. Mechanical electricity is electricity that is produced by motion.

C. Fill-in-the-blank:

8. Electrons travel in orbits around the atom and carry a _____ electrical charge.

9. Protons are large particles which carry a _____ electrical charge.

D. Short Answer:

10. If an electrical heater used 500 watts for 10 hours and the cost of electricity is 20 cents per kilowatt answer the following questions.

How many kilowatts are used?

_____

What is the cost of using the heater for 10 hours?

_____